



**Royal  
HaskoningDHV**  
*Enhancing Society Together*



U.S. Department of Transportation  
**Federal Highway  
Administration**



**DUTCH  
CYCLING  
EMBASSY**

---

# **Thinkbike workshop Cycling Networks, CROW Requirements, Multimodal Perspectives**

---

Arie Vijfhuizen

---

# Content of this presentation

1. Who am I?
2. Cycling network
3. Main Requirements
4. Routes
5. Sections and junctions
  - How to design a bicycle path / lane
  - Sections
  - Junctions
6. Multimodal Perspectives

---

# 1. Who am I?

Arie Vijfhuizen, 54 years, Married  
Two children (girl 18 and boy 14)

## Leisure activity →

Running, internet, reading, photography, walking in the nature and a lot of other things

## Work →

8 years RHDHV + about 20 years experience in:  
road design, road safety and cycling  
24 years worked for various Governments such as  
Ministry and various municipalities (including the  
city center of Amsterdam)



---

## *2. Cycling Network*

# *How to design Bicycle facilities*

## Road categorization

Through roads: Long distance traffic

Distributor roads: Connects areas

Access roads: Access to properties

Urban area:

Consequences:

- Network
- Routes
- Sections
- Junctions

Distributor road

30 mph

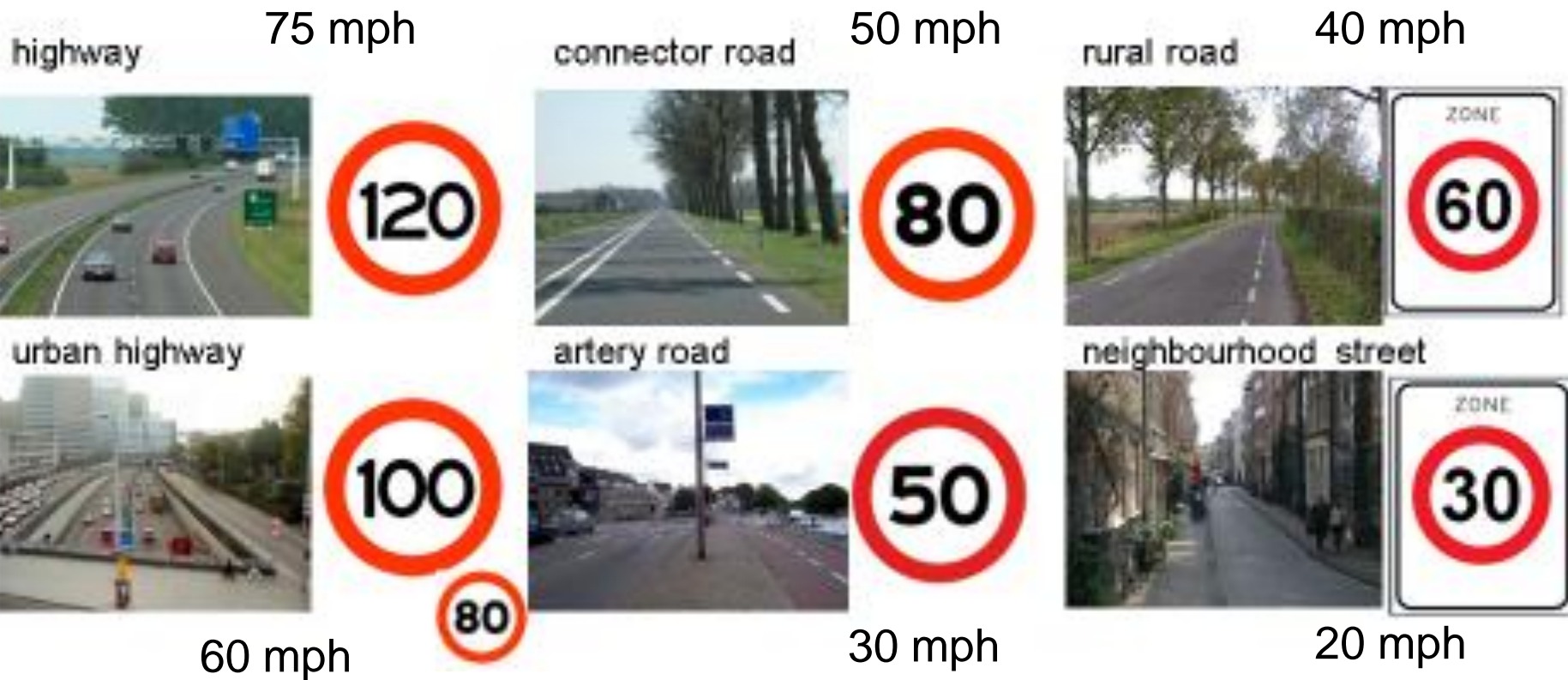


Access road

20 mph







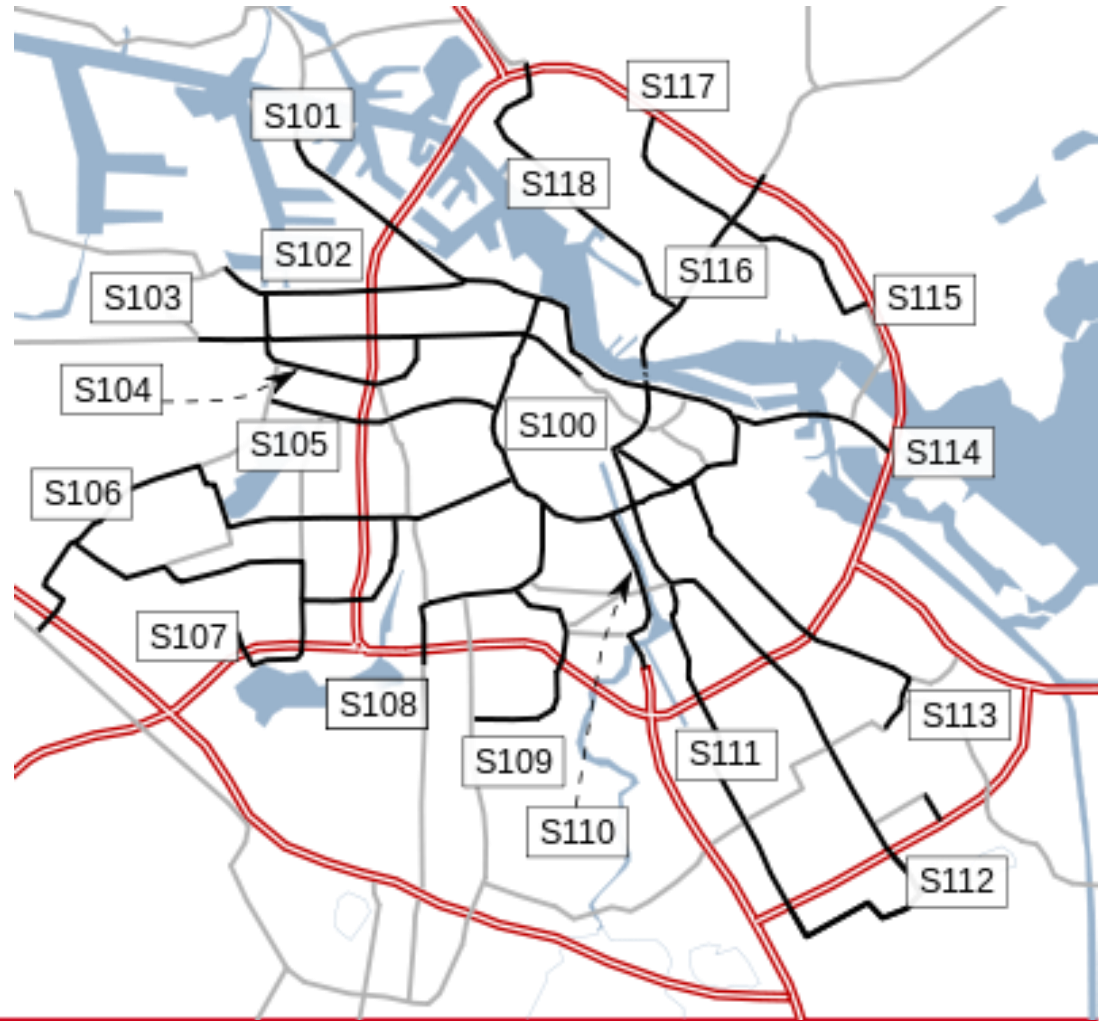
Mixing of transport modes in street profiles

---

# *How to design a network?*

- Define the area
- Select Origins and Destinations
- Distinguish O and D by importance
- Connect Origins and Destinations
- Distinguish main routes
- Cover the whole area
- Connect to surrounding areas

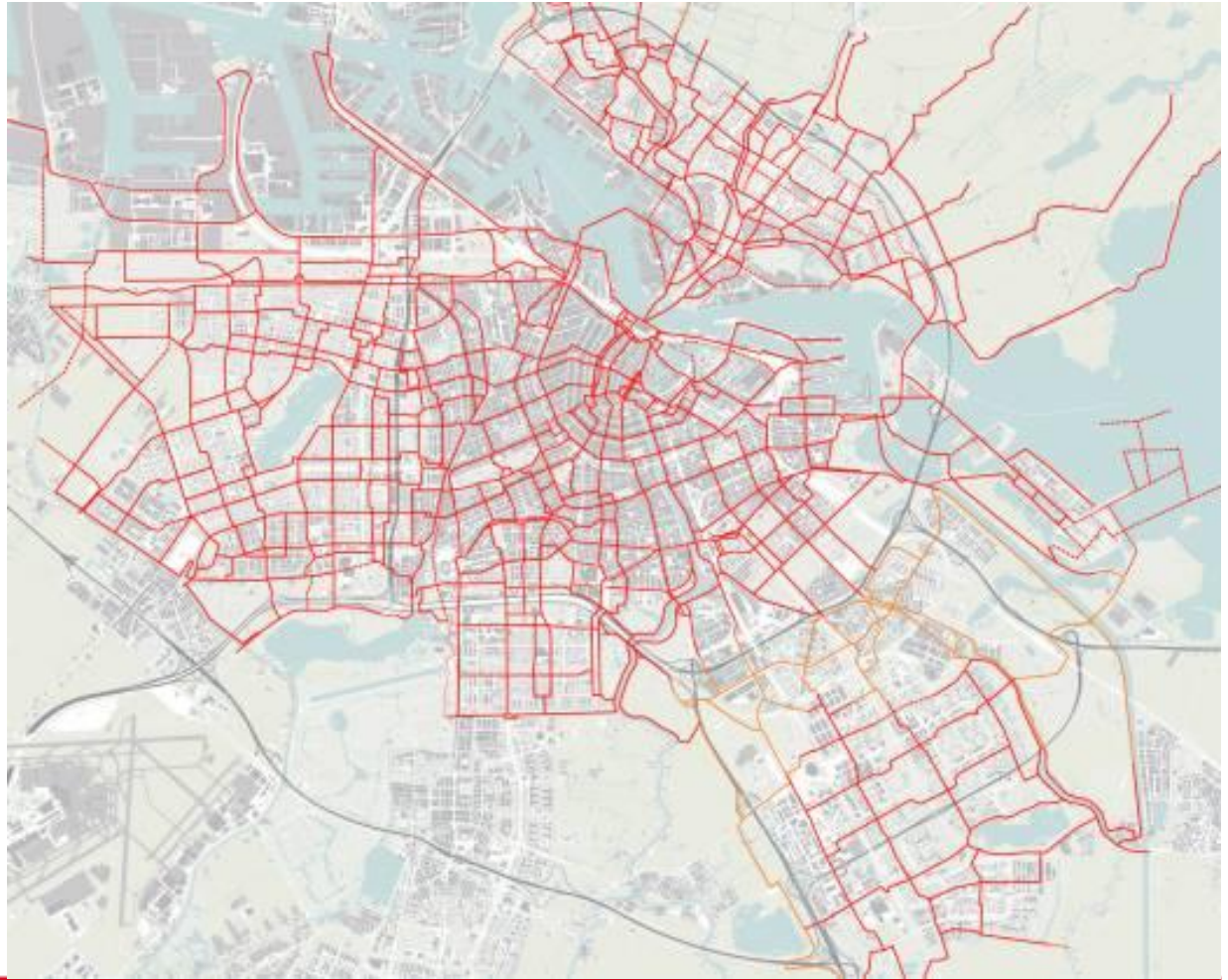
# *Network cars Amsterdam*



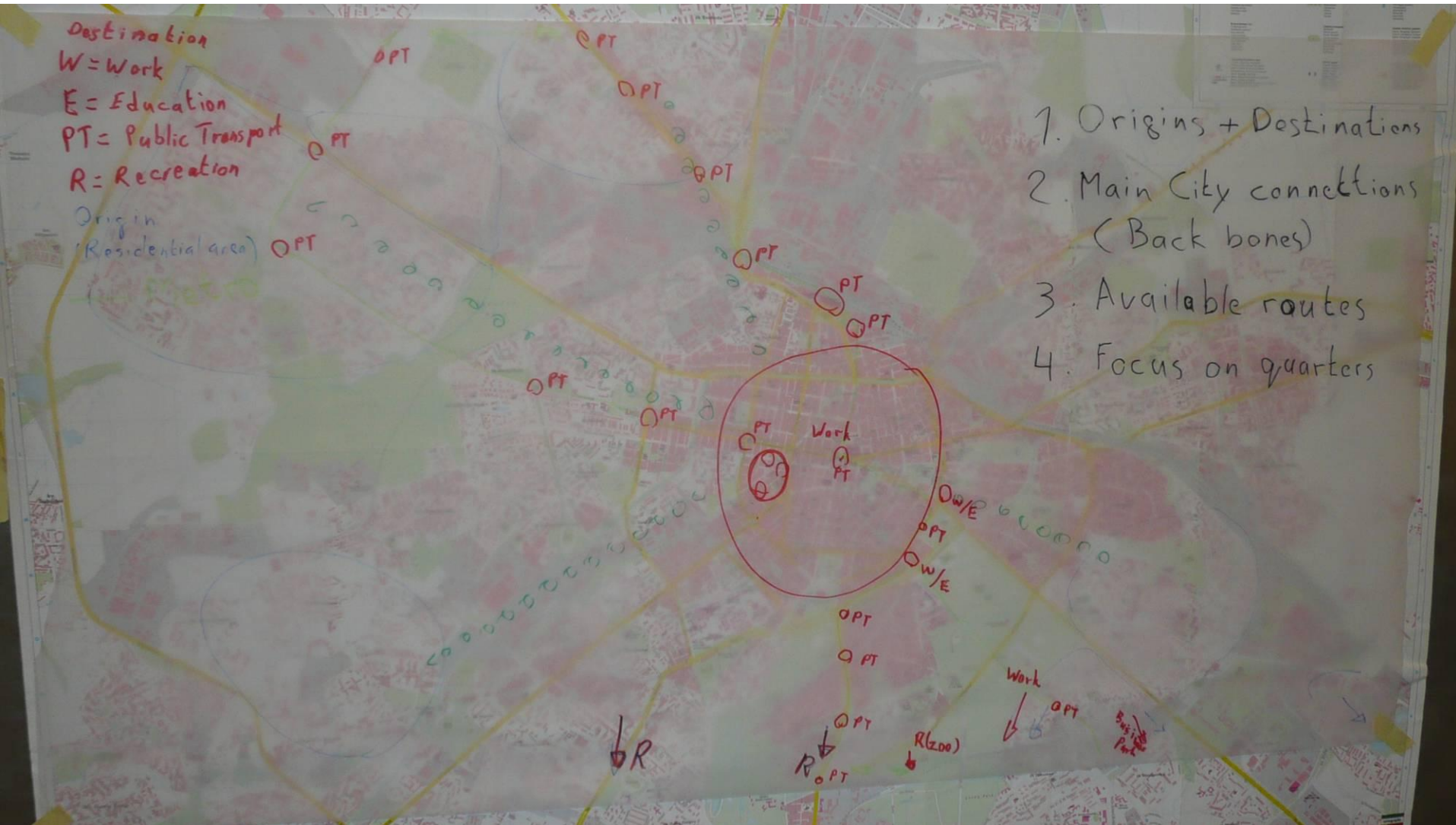


---

# *Network cycling Amsterdam*



# Network: example Skopje





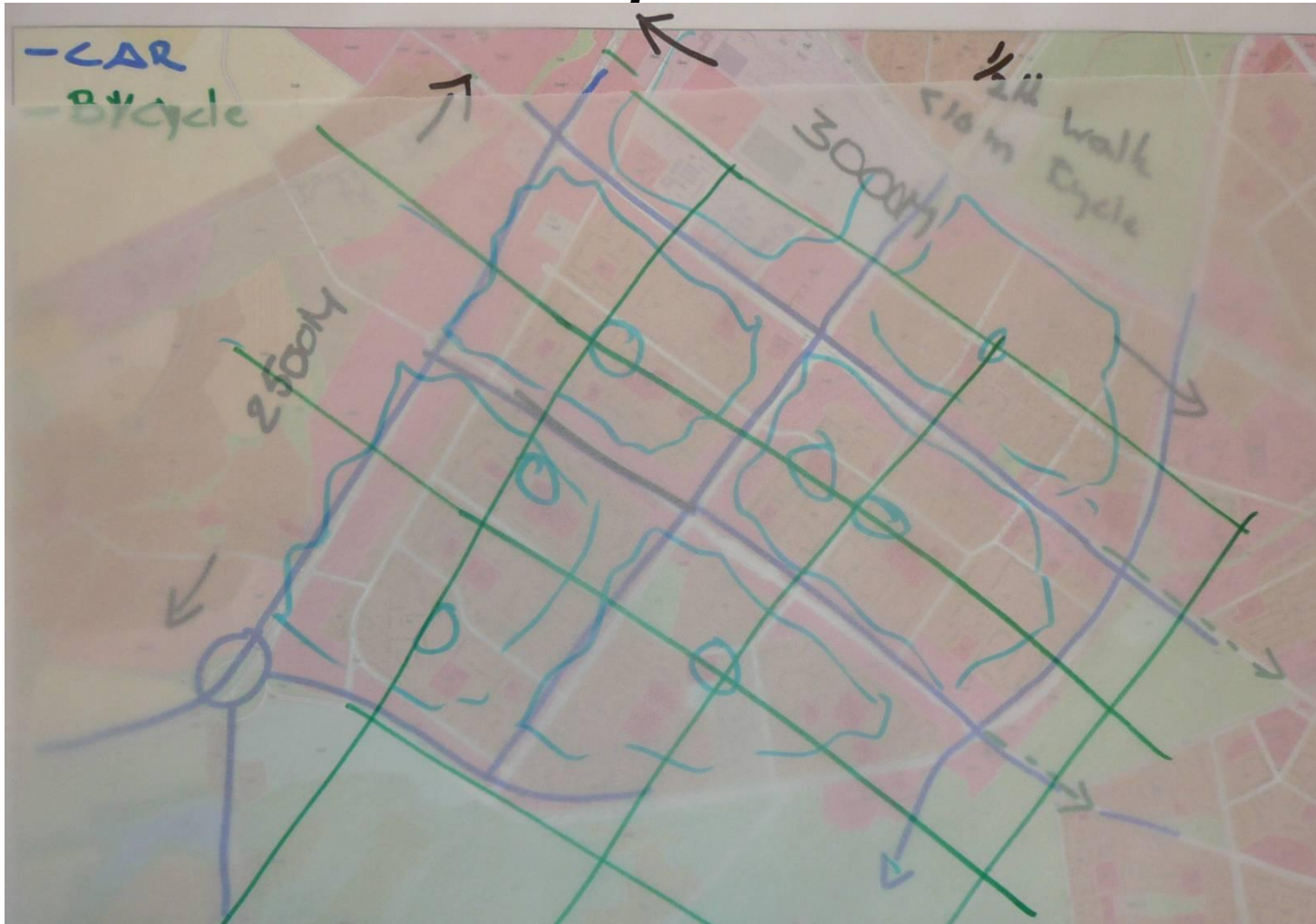
# Network: example Sofia



# Network: example Sofia



# Network: example Sofia





# Network: example Sofia





---

# *3. Main requirements*

# Main requirements

NEEDED = DOOR TO DOOR MOBILITY POLICIES

Safety



Comfort

Directness



Cohesion

5 main  
requirements



Attractiveness

---

# *Main requirements*



Cohesion

Cohesive whole  
(network / route)

From origin to destination

- availability
- ease
- quality
- freedom

# *Main requirements*



Cohesion

## Complete network:

- parallel routes

## Complete routes:

- centres / main destinations
- high potential main routes

## Recognisability:

- route as such is clearly ongoing



---

# *Coherent mobility*

- Connectivity
- Recognisability
- Continuity
- Signposting



# Main requirements



Directness

As direct as possible  
(route)

From origin to destination  
Minimum travel time

- traffic flow speed
- stops (number and length)
- detours (distance)



# Main requirements



Directness

## Distance:

- minimal detours
- minimal bending and winding
- avoid illegal movements

## Time:

- minimal number of stops or delay

# Main requirements

## Vulnerability

- (mass / speed / no technical provisions)

## Save conditions:

- Separation in time or space

- big residential areas
- avoid dangerous routes
- short journeys
- shortest = safest
- ease
- avoid conflicts
- reduce speed



Safety

# Main requirements

## Crossing traffic conflicts:

- minimal number of meetings

## Vehicle separation:

- in case of major speed differences

## Speed reduction:

- at level crossings main traffic routes

## Road categories:

- recognizable, uniform solutions

## Sufficient visibility (day and night)

## Avoid obstacles



Safety



# *Innovations in the Netherlands*



---

# *Main requirements*



Comfort

Minimum nuisance and delay (journey)

Avoid additional physical effort

- smoothness of pavement
- hilliness
- chance of stopping
- weather
- traffic

# Main requirements



Comfort

## Traffic nuisance:

- minimize number of meetings, noise, pollution

## Flow:

- minimize probability of speed reduction, waiting and delay

## Smoothness:

- surface, preferably asphalt or concrete

## Comprehensibility:

- mental map, signposting

## Gradient and weather nuisance



# *Main requirements*



Attractiveness

Cycling has to be pleasant  
(journey)

Varies per person and per motif;  
Psychological: perception

e.g.:

- quiet
- smooth
- safe
- beauty (nature / buildings)

Also: social safety

# Main requirements



Attractiveness

## Social safety:

- social control at busy routes
- safe alternative
  - visibility (surroundings)
  - public lighting
  - maintenance

## Traffic nuisance:

- separation with busy traffic (motor vehicles) related to surroundings

---

## 4. *Routes*

---

# *How to design a route?*

- Define Origin(s) and Destination(s)
- Find and compare possible routes
- Advise related to main objectives
- Weight alternatives
- Think in opportunities
- Connect to other routes (existing and planned)

---

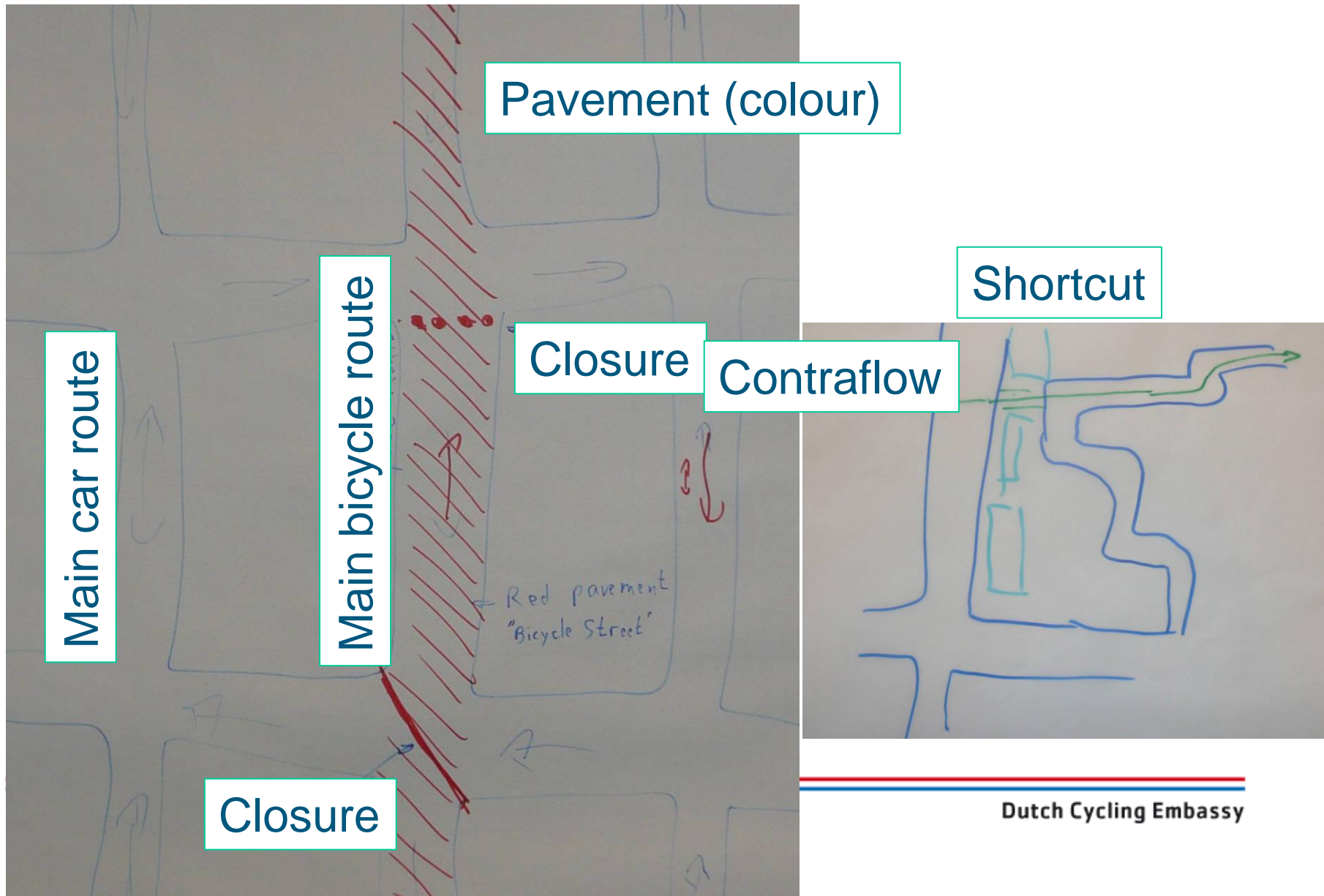
# *Routes: where to implement*

Along (existing) arterial or back streets?

- Arterial:
  - ✓ Usual straight
  - ✓ Destinations
  - ✓ Mental map
  - ✓ Social controlled
- Back streets (residential areas, parks):
  - ✓ Safe (except crossings)
  - ✓ Attractive
  - ✓ Relatively cheap

Disadvantages back streets more easily to compensate  
Arterials always available as alternative

# *Routes: example backstreets*





---

# *Routes: example pavement*



---

# *Routes: example pavement*





---

# *Routes: example closure*





# *Routes: example contra flow*

Common practice

Still legal exception









---

# *Routes: example shortcut*





# *Routes: example shortcut*



---

# *Routes: example shortcut / closure*





---

## *5. Sections and Junctions*

---

# Sections → Design bicycle path / lane / street

Choose type of solution:

- Bicycle path or lane or bicycle street
- With or without mopeds
- One or two way bicycle traffic

Most important aspects:

- Separation
- Width
- Surface

# Sections

## Separation

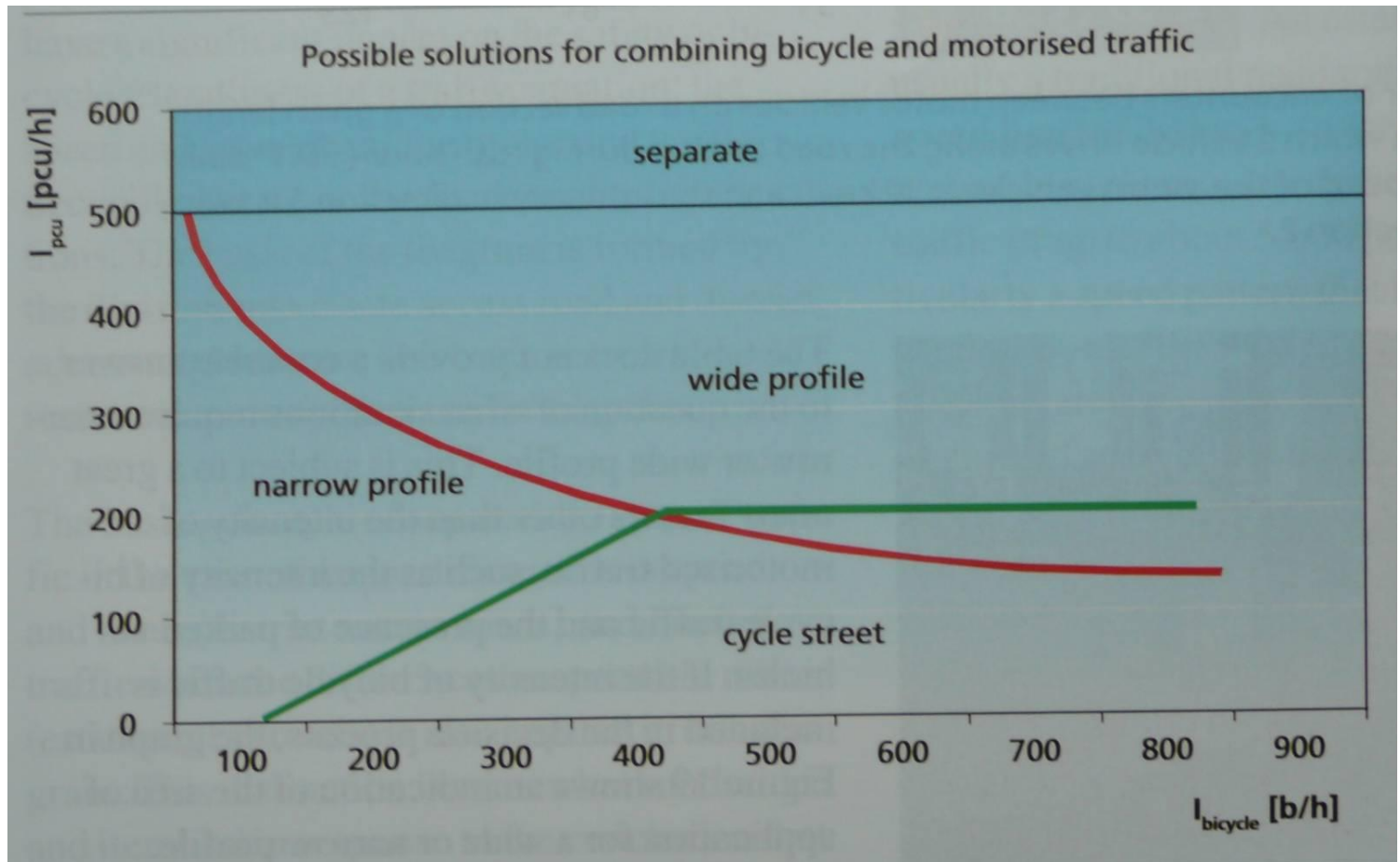
Distributor road   Access road

Table 14. Option diagram for road sections inside the built-up area

Road category	Max. speed of motorised traffic (km/h)		Motorised traffic intensity (pcu/day)	Cycle network category		
				basic network ( $I_{\text{bicycle}} > \text{work } 750/\text{day}$ )	cycle route ( $I_{\text{bicycle}} 500-2500/\text{day}$ )	main cycle route ( $I_{\text{bicycle}} > 2000/\text{day}$ )
	n/a		0	solitary track		
Estate access road	walking pace or 30 km/h		1 - 2.500	combined traffic		cycle street or cycle lane (with right of way)
			2.000 - 5.000			
			> 4.000	cycle lane or cycle track		
District access road	50 km/h	2x1 lanes	irrelevant	cycle track or parallel road		
		2x2 lanes				
	70 km/h			cycle track, moped/cycle track or parallel road		

# Sections

## Separation / combined use





---

# *Bicycle path / track*

## **Separate path:**

Distributor roads

Main bicycle routes

Car parking

Physical space

- Function ▶width, surface
- Volume of cyclists ▶width
- Mopeds ▶width
- One or two way ▶width



# *Bicycle lane*

## **Bicycle lane:**

- Little space ► low volume / speed
- Car parking ► too high → no lanes
- Function ► width
- Volume of cyclists ► width



# *Bicycle lane*

## Bicycle lane:

- Red colour
- Continuous line: 2.00 – 2.50 m
- Interrupted line: 1.50 – 2.00 m → discussion about minimum of 1.70 m





# *Bicycle street*

## **Bicycle street:**

- Two directions
- Red colour
- No signs
- Maximum 200 pcu/hr
- Speed reduction





---

# *Junctions*

---

# *How to design junction / crossing*

## Choose type of solution:

- Give way + additions  
(refuge island, speed hump, narrowing)
- Roundabout
- Traffic lights
- Grade separate (bridge, tunnel)
- Do nothing (or just add minor adjustments)

# Junction / crossing

Type of junction: Distributor road – access road

Distributor road

Table 24. Option table: district access road – estate access road intersection solutions

		Section 2: estate access road or solitary path			Access road
		$I_{pcu} < 500$ pcu/h			$I_{pcu} > 450$ pcu/h
Section 1: district access road, with or without (main) cycle route	hourly intensity	no cycle route	cycle route	main cycle route	all situations
	1-1,000 pcu/h	right of way intersection		right of way intersection + supplementary measures or roundabout	roundabout
	800 - 1,500 pcu/h	right of way intersection + supplementary measures		right of way intersection + supplementary measures or roundabout	
	1,200 - 1,750 pcu/h	right of way intersection + supplementary measures, roundabout, intersection with TCS or grade-separated intersection (only for main cycle route where appropriate)			
	> 1,500 pcu/h	intersection with TCS or grade-separated (only for main cycle route where appropriate)			roundabout, intersection with TCS or grade-separated solution

# Junction / crossing

## Type of junction: Distributor roads

### Distributor road

Section 1: district access road, with or without (main) cycle route		Section 2: district access road, with or without cycle route ( $I_2 \leq I_1$ )			
		Distributor road			
		$I_2 < 1,200$ pcu/day			$I_2 > 1,000$ pcu/day
		hourly intensity ( $I_1$ ) pcu/h	no cycle route	cycle route	main cycle route
	500 - 1,500		single lane roundabout		roundabout (if necessary with bypass or two-lane) or TCS
	1,200 - 1,750		roundabout (if necessary with bypass or two-lane) or TCS		(multi-lane) roundabout with cycle tunnel in busiest lateral direction (or TCS)
	> 1,500		(multi-lane) roundabout or TCS	(multi-lane) roundabout with cycle tunnel in busiest lateral direction (or TCS)	TCS or grade-separated



---

# *Junction / crossing*

## Additions:

- Speed hump / plateau
- Refuge island
- Narrowing
- Bollards
- Public Lighting
- Continuous material, colour

---

# *Junction / crossing: Give way*

## Give way + additions:

- Function ►type additions
- Volume of cyclists ►type, dimensions



# *Junction / crossing: Give way*

Examples: Separate crossing

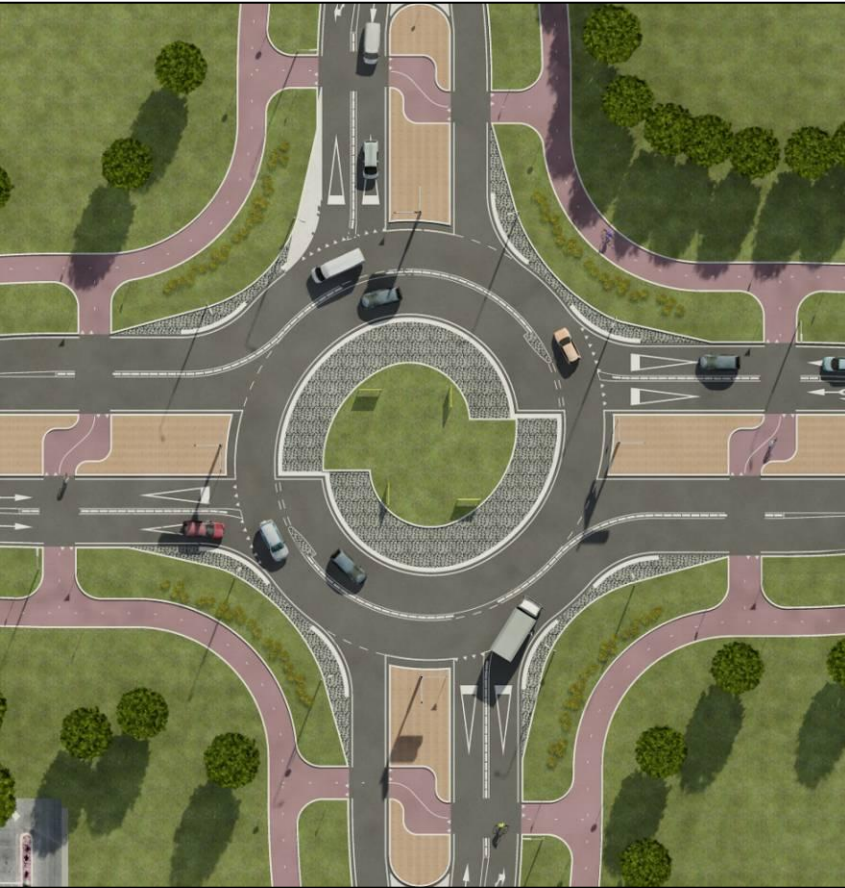




---

# *Junction / crossing: Roundabout*

Multi lane roundabout:



Single lane roundabout:



# *Junction / crossing: Traffic lights*

## Examples bicycle friendly adds

### Green wave



### Rain sensitive traffic lights



# *Junction / crossing: Traffic lights*

## Examples bicycle friendly adds

All directions green



Waiting time predictors



# *Junction / crossing: Grade separate*

## Bridge or tunnel?

- Bridging ▶ tunnel
- Comfort ▶ tunnel
- Ecological ▶ tunnel
- Social safety ▶ bridge
- Costs ▶ bridge
- Spatial fit
  - ▶ tunnel: “invisible”
  - ▶ bridge: architectural pleasing

Option: half bridge, half tunnel



# *Junction / crossing: Grade separate*

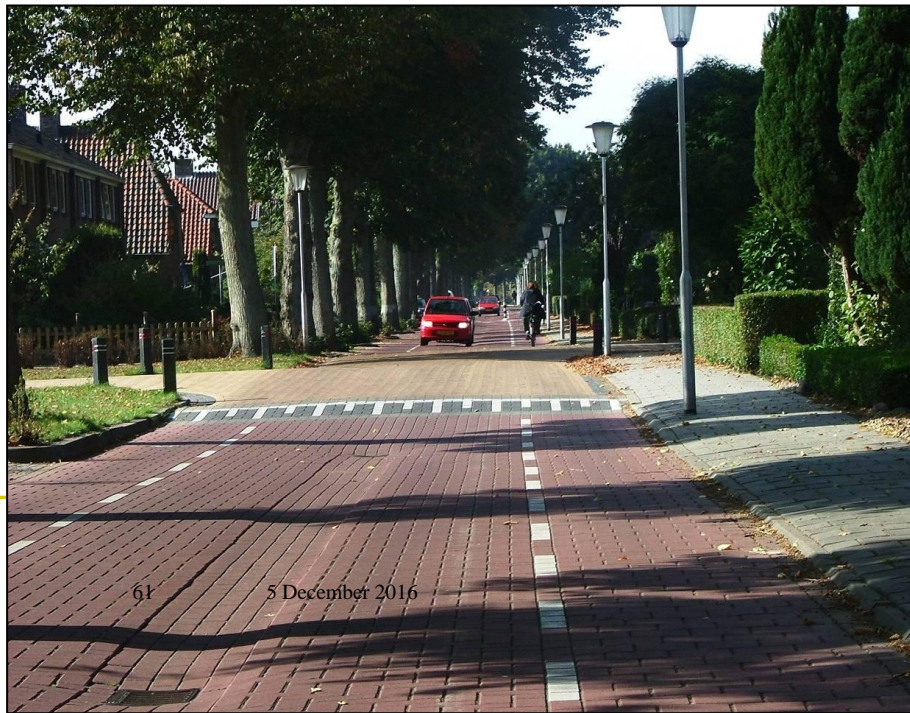
Examples bridge / tunnel





# Junction / crossing: Do nothing

Or add plateau /  
raised junction table

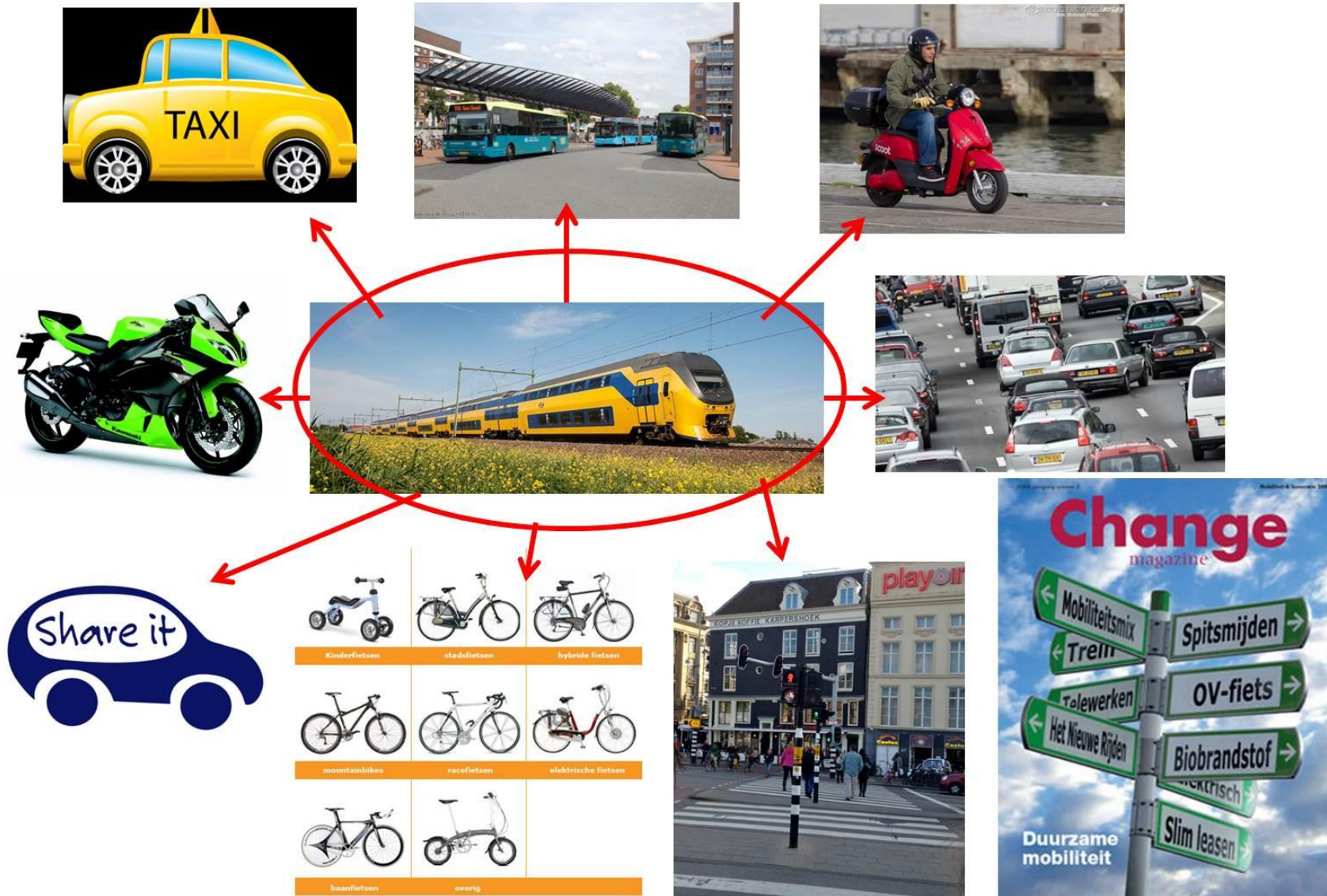




---

## *6. Multimodal Perspectives*

# Chain mobility → Transit



---

# OV-fiets (PT-bicycle)

- National public bicycles system
- More than 10,000 bicycles on more than 300 locations
- More than 160,000 subscribers
- More than 1'400,000 trips
- Improved availability bicycles for egress trips





---

# *Any questions?*



*End of my presentation*

